TSUNAMI NEWSLETTER

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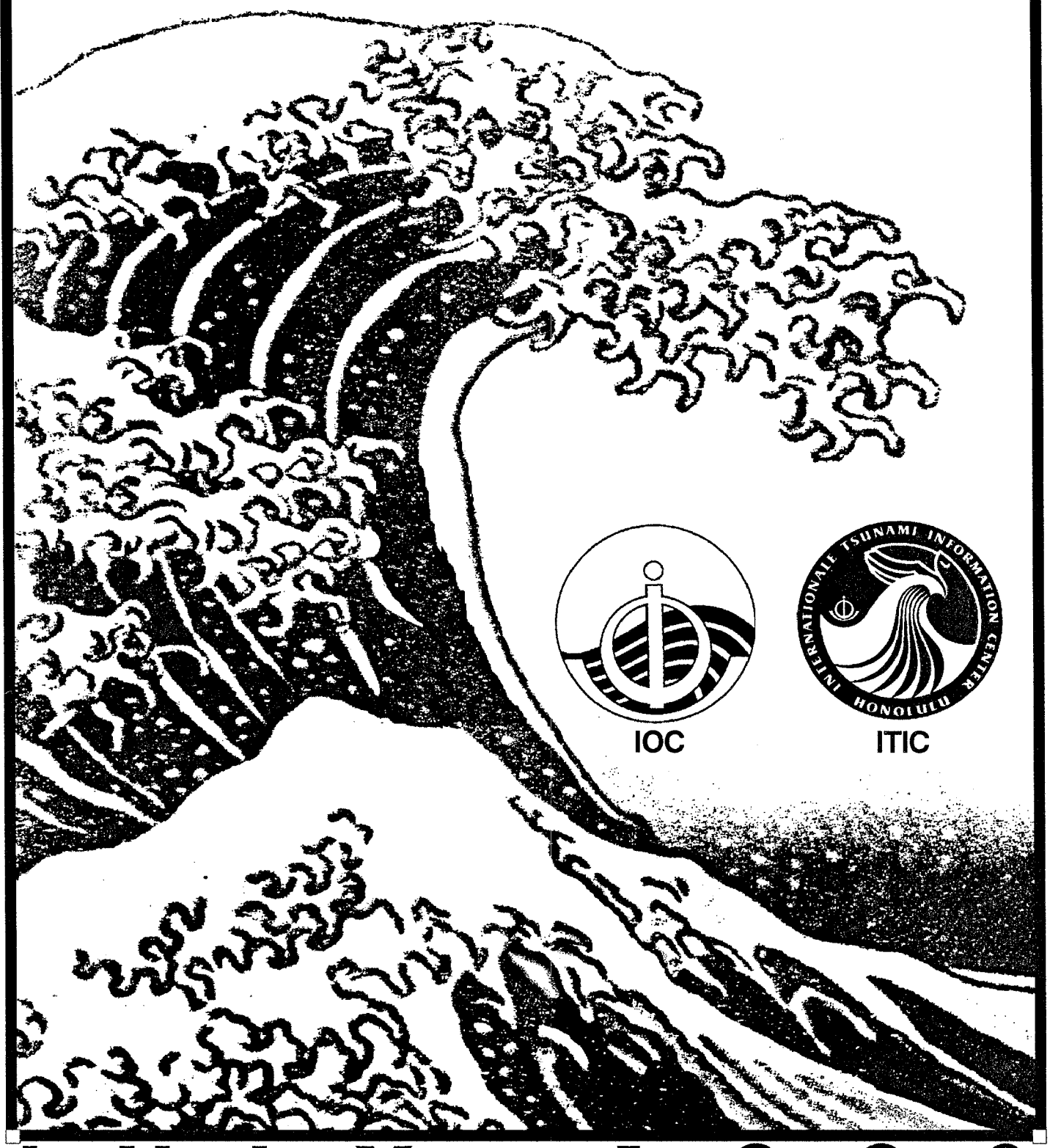

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JULY • 1993

Tsunami Newsletter- July 1993

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TSUNAMI NEWSLETTER is published by the International Tsunami Information Center to bring news and information to scientists, engineers, educators, community protection agencies, and governments throughout the world.

We welcome contributions from our readers.

The International Tsunami Information Center (ITIC) is maintained by the U.S. National Oceanic and Atmospheric Administration (NOAA) for the Intergovernmental Oceanographic Commission (IOC). The Center's mission is to mitigate the effects of tsunamis throughout the Pacific.

MEMBER STATES
Present membership of the IOC International Coordination Group for the Tsunami Warning System in the Pacific (ITSU) comprises of the following States:

AUSTRALIA
CANADA
CHILE
CHINA
COLOMBIA
COMMONWEALTH OF INDEPENDENT STATES (FORMERLY USSR)
COOK ISLANDS
COSTA RICA
DEMOCRATIC PEOPLE'S REPUBLIC OF KOREA
ECUADOR
FIJI
FRANCE
GUATEMALA
INDONESIA
JAPAN
MEXICO
NEW ZEALAND
NICARAGUA
PERU
PHILIPPINES
REPUBLIC OF KOREA
SINGAPORE
THAILAND
UNITED KINGDOM (HONG KONG)
UNITED STATES OF AMERICA
WESTERN SAMOA

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News Events

Earthquakes and Tsunamis

... *at Press Time* ...

A large (magnitude Ms 7.6) earthquake occurred in the Sea of Japan on 12 July (1317 UTC). Reports indicate a tsunami was generated in the Sea of Japan with one account noting a wave height of three meters on western Hokkaido Island. A full report on this event will be forthcoming in the December 1993 ITIC Newsletter.

Since the last ITIC Newsletter (December 1991) two disastrous tsunamis caused substantial loss of life and extensive damage in Nicaragua and Indonesia. Each tsunami, associated with a near-field seismic event, had devastating effects, but also provided researchers with important field data for numerical models and developing guidelines for hazard mitigation.

A third event, the Cape Mendocino, California, earthquake and tsunami, caused little or no damage, but provided a wealth of seismic and water level data. Dr. Eduardo Camacho of the Institute of Geosciences (University of Panama) provided an interesting report on the April 1991 tsunami in Panama.

The following *condensed* reports were extracted from previously published articles or papers planned for publishing. As a matter of style, an abbreviated set of references appear in this newsletter article; please refer to the original publication(s) for an extensive set of references. And, as additional information and field evidence become available on these tsunamis, we will endeavor to cover those reports in future editions of the ITIC Newsletter.

Nicaragua, Earthquake and Tsunami

Tsunami Field Survey of the 1992 Nicaragua Earthquake

Kenji Satake, Joanne Bourgeois, Kuniaki Abe, Katsuyuki Abe, Yoshinobu Tsuji, Fumihiko Imamura, Yoshihisa Iio, Hiroshi Katao, Evelyn Noguera, Francisco Estrada; **EOS, Transactions, American Geophysical Union, Vol. 74, No. 13, Pages 145, 156, 157 (1993).**

Introduction and Overview

An earthquake with a surface magnitude (Ms) 7.0 occurred off the Nicaraguan coast on September 2, 1992 (GMT), or in the evening (7:16 P.M.) of September 1, local time.

Despite its moderate size, this earthquake generated a sizable tsunami, which caused extensive damage along the coast of Nicaragua.

The exact number of casualties is not known, but as of the end of September, 168 people, mostly children, were listed as dead or missing, 489 injured, and over 13,000 homeless, with more than 1500 homes destroyed. The tsunami damage is the most significant since the 1983 Japan Sea earthquake and tsunami, which killed 100 people in Japan.

Using semi-real time accessibility of seismic and tide gauge data, we have made a preliminary analysis of this earthquake and tsunami. Results indi-

cate that this earthquake had the features typical of a "tsunami earthquake," defined as an earthquake that generates an unusually large tsunami relative to earthquake magnitude. It is different from a "tsunamigenic earthquake," which describes any earthquake that generates a tsunami. Several "tsunami earthquakes" have been identified in the past century, including the 1896 Sanriku, Japan, and the 1946 Aleutian, earthquakes (Kanamori, 1972). The generation mechanism of these unexpectedly large tsunamis is not yet well understood.

In order to document this rare tsunami, we made a survey of the Nicaraguan coast in late September. Data collected, combined with observations by other groups, will be useful for future studies including mechanisms of tsunami earthquakes, coastal behavior of tsunamis, environmental effects of tsunamis, and hazard mitigation.

The data collected from this event will be valuable for future studies on various aspects of tsunamis. The mechanism of "tsunami earthquakes" can be studied by comparing numerical computations from various source models with field observations. The nearshore behavior of tsunamis will be studied both numerically and experimentally.

The study of tsunami deposits from this event may provide a unique calibration for geologists who study paleotsunami deposits and try to estimate paleoseismology. In addition, the collected data will help planners in developing guidelines for tsunami hazard mitigation, both in Nicaragua and along other coastlines susceptible to tsunamis.

Reference

Kanamori, H., Mechanism of tsunami earthquakes, Phys. Earth Planet. Inter., 6, 346-359, 1972.

(For those interested in additional information on this event see related ITIC Newsletter article, Nicaraguan Tsunami Bulletin Board.)

Flores Island, Indonesia, Earthquake and Tsunami

The Flores Island Tsunamis
by the International Flores Tsunami Team*

* The survey team consisted of the following people (in alphabetical order): Byung Ho Choi (Korea), Gunawan (Indonesia), Motohiko Hatano (Japan), Fumihiko Imamura (Japan), Yoshiaki Kawata (Japan), Philip L.F. Liu (USA), Hideo Matsutomi (Japan), Masashi Matsuyama (Japan), Prih Hadjardi (Indonesia), Shaozhong Shi (U.K.), Junichi Shibuya (Japan), Sunarjo (Indonesia), Costas Synolakis (USA), Tomoyuki Takahashi (Japan), Minoru Takeo (Japan), Yoshinobu Tsuji (Japan), and Harry Yeh (USA). The manuscript was prepared by Harry Yeh and Fumihiko Imamura.

Overview

On December 12, 1992, 5:30 am GMT (1:30 pm local time), an earthquake of magnitude Ms 7.5 struck the eastern region of Flores Island, Indonesia. The local newspaper reported that 25

region of Flores Island, Indonesia. The local newspaper reported that 25 meter high tsunamis[1] struck the town of Maumere causing substantial casualties and property damage. On December 16, television reports were broadcast in Japan via satellite reporting 1,000 people killed in Maumere and two-thirds of the population of Babi island swept away by the tsunamis.

All preliminary information indicated that this was a major tsunami catastrophe. The present toll of this Flores earthquake is 2,080 deaths and 2,144 injuries. Approximately one-half of the deaths and injuries are attributed to the tsunamis. A tsunami survey plan was initiated within three days of the earthquake. A cooperative international survey team was formed consisting of five scientists from Indonesia, nine from Japan, three from the United States, one from the United Kingdom, and one from Korea.

Abstract

Tsunamis associated with the 1992 Flores Island Earthquake caused substantial casualties and damage. A giant tsunami runup of more than 26 meters in height was recorded. Massive subaqueous slumps with vertical dislocation of more than 20 meters were observed. Some villages were totally destroyed. This seismic catastrophe caused large-scale geomorphological changes to Flores Island.

[1] Later on, measurements found that the actual tsunami height in Maumere area was much smaller, about 3 meters high.

Ironically, this devastating phenomenon was an extremely rich event from a scientific point of view. The results of the tsunami field survey and the observations of several unusual phenomena are reported here.

Some Observations Related to the Flores Island Earthquake and Tsunami,
F. Gonzalez, S. Sutisna, P. Hadi, E. Bernard and P. Winarso

Abstract

Documentation of the 12 December 1992 Flores Island, Indonesia earthquake and tsunami is presented in the form of solid earth, oceanographic, and aerial photography data, and preliminary estimates of death and damage. Geodetic estimates of crustal deformation at Maumere and 16-day aftershock distribution are examined and found to be consistent with crustal deformation computations based on the Harvard CMT solution for the main shock. However, computed maximum uplift is insufficient (about 1.5 meters) to account for very large tsunami values (12-20 meters) observed by the International Flores Island Survey Team *[see previous article]*.

Tsunami data include a tide gauge record at Palopo, 650 kilometers north of the epicenter, and aerial photographic survey data, consisting of more than fifteen hundred overlapping images of approximately 300 kilometers of the Flores Island coastline. The first tsunami wave cycle at Palopo is characterized by positive first motion 104 minutes after the main shock, a maxi-

mum of 27 centimeters and minimum of -47 centimeters, and a period of 69 minutes. Two air photos are presented; these were taken before and after the disaster, and clearly document the total destruction of Kampungbaru, a small village on Babi Island. These photos demonstrate the value of aerial photography in the collection of tsunami data.

Cape Mendocino, California, Earthquake and Tsunami

Tsunami Inundation Model Study of Eureka and Crescent City, California; and, The Cape Mendocino Tsunami;
by F. I. Gonzalez and E. N. Bernard, NOAA/PMEL

Background

The Cape Mendocino, California, earthquake of April 25, 1992, generated a tsunami that was recorded by NOAA sea-level gauges along the coast of California, Oregon, and Hawaii and the Gulf of Alaska.

As seen in Figure 1, the maximum tsunami amplitude was about 60 centimeters at Crescent City and occurred about three hours after the earthquake origin time. The tsunami arrived in Eureka about 20 minutes after the earthquake, fortunately at low tide. The fact that the tsunami was detected at numerous sites in California and Hawaii gives rise to concerns about larger earthquakes that may generate larger tsunamis.

Seismologists are intensively studying this earthquake, using a variety of data sources: teleseismic body waves, surface waves, aftershock data from regional networks, and geodetic observations. Fault model parameters will be obtained through analysis of these data. This fault model will provide a tsunami source that is consistent with the seismological constraints.

Significance of this Tsunami - Hazard Mitigation Issues

Although not destructive, this tsunami is significant because it illustrates many important issues relevant to hazard management.

First, the data presented here clearly illuminate two important features that make tsunamis particularly dangerous:

(a) Tsunami are a *rapid onset* natural hazard. Nearby coastal communities have little or no time before the arrival of a locally generated tsunami. For example, at Eureka, 50 kilometers from the source region, wave activity began within 20 minutes of the earthquake. Effective hazard mitigation must emphasize rapid evacuation. Coastal communities should consider the earthquake itself to be the first warning that a potential tsunami hazard exists.

(b) The tsunami danger can be of *relatively long duration*. For example, on April 25 the first wave arrived at Crescent City in less than an hour, but the record shows that the maximum wave heights occurred three-four hours later. Tsunami wave activity persisted for more than eight hours. Effective hazard management must therefore ensure that (1) citizens do not return to

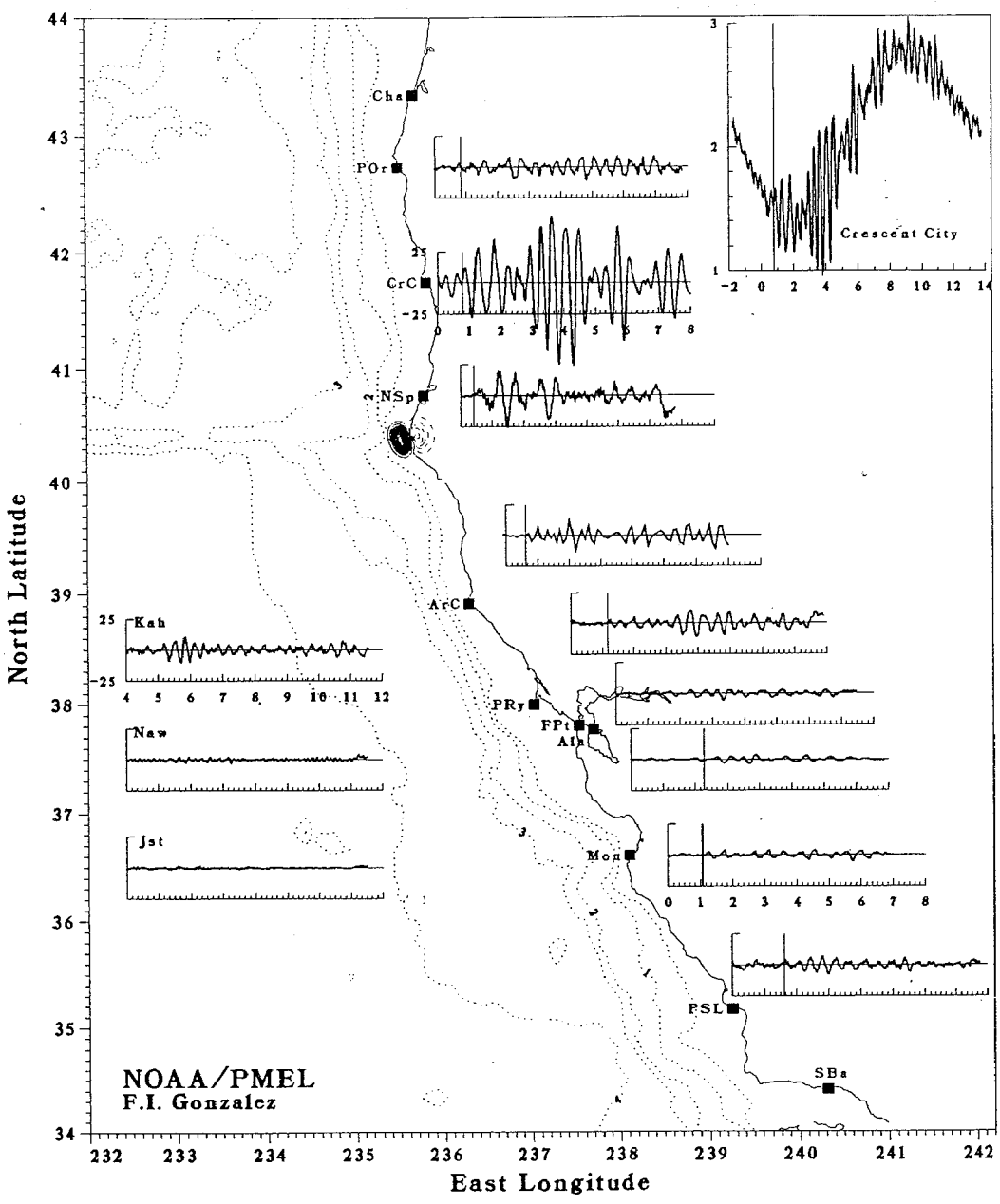

Figure 1. Summary of NOAA tide gauge measurements of the April 25, 1992, Cape Mendocino tsunami. For all records except Crescent City (inset), the tidal signal has been filtered out, the horizontal scale is hours referred to the main earthquake shock, and the vertical scale is ±25cm. The inset is the unfiltered Crescent City tidal record with vertical scale in meters. Solid, vertical lines on these plots represent preliminary computations of tsunami arrival times. Three-letter labels are station name abbreviations; Kah and Naw refer to Kahului and Maui in the Hawaiian Islands, and Jst to Johnston Island, southwest of Hawaii. The dipole pattern just south of the North Spit (NSp) station near Eureka, California, represents the uplift and subsidence predicted by a preliminary fault plane earthquake model.

low lying areas prematurely, and (2) provisions are made for the needs and safety of citizens during an extended evacuation period. Second, the data associated with this uncommonly well-documented tsunami are exceptionally valuable. They will be used to test existing tsunami theory and numerical models. This has great practical significance in hazard mitigation and management. Harbor and breakwater designs that minimize tsunami damage and maps that show areas subject to inundation by tsunamis require accurate numerical models and a thorough understanding of tsunami dynamics.

Finally, the association with the Cascadia Subduction zone makes this tsunami particularly significant. Many geophysicists believe that the Cascadia Subduction Zone is capable of producing a great earthquake, a shock much stronger than the April 25, 1992 mainshock. Such a shock would almost certainly generate a large and destructive tsunami.

Population growth and the continuing development of our coastal regions are raising the potential losses associated with future tsunamis.

The Tsunami of April 22, 1991 in Central America

Dr. Eduardo Camacho of the Institute of Geosciences of the University of Panama provided the following information on the tsunami of April 22, 1991, in Panama:

There have been other events which have caused tsunamis on the Caribbean coast of Panama, including those in 1882 (in the San Bias Archipelago, northeastern Panama) and on April 25, 1916, and April 22, 1991 (in the Bocas del Toro Archipelago in northwestern Panama).

The following is a short report provided by people at Bocas del Toro Island. They reported that shortly after the earthquake on April 22, 1991, (less than ten minutes) the sea receded and Las Delicias sand bank that usually is covered by two to three feet of water emerged to the surface like a submarine for five to seven minutes.

After this time period, several waves started to enter the bay from the northeast with great force. The water flooded some 50 to 100 meters inland, mainly in the northern part of the town which is extremely flat. As the fury of the sea continued, people became afraid and started to evacuate the town to the surrounding hills. Some people reported that this perturbation lasted several hours and that the sea was very dirty and muddy.

At San Cristobal Island people reported that the sea receded several meters for about 45 minutes. Because many fish got trapped, people ran onto the beach to catch the fish. This happened near the mouth of the river. At Carenero Island, the inhabitants took their canoes and headed to more protected neighboring islands. Ten to twenty minutes after they departed, a violent wave finished the destruction of their dwellings.

When recorded by the tide gauge at Colon, this tsunami appeared to be small.

Transitions

Bernard David Zetler Dies

Bernard David Zetler, 76, an oceanographer affiliated with the University of California, San Diego, Scripps Institution of Oceanography for many years, passed away on September 25, 1991.

An expert on tides, nearshore currents, and tsunami waves, Zetler joined the Institute of Geophysics and Planetary Physics at the Scripps Institution in 1972. He retired from full-time employment in 1985, but remained a research associate on the Scripps faculty.

He is most widely known for his research on seismically caused sea waves known as tsunamis. Zetler's professional career began in 1938 when he became a mathematician and oceanographer with the United States Coast and Geodetic Survey, now known as the National Ocean Service. Among his first assignments with the Coast Survey was placement of an operational tsunami warning system for the Aleutian Islands, Kamchatka, Japan, Chile, and Hawaii.

Zetler served on numerous international scientific committees, particularly those dealing with tsunamis.

He served as Chairman of the International Union Geodesy and Geophysics (IUGG) Tsunami Committee and was a member of the U.S. Delegation to the International Oceanographic Commission meetings on tsunami warning systems. In 1981, Zetler was the only honored foreign speaker at the opening ceremonies for the IUGG Symposium in Sendai, Japan.

He was awarded the U.S. Department of Commerce Silver Medal in 1966 for his research.

ITIC

WELCOME!

It has been over a year since the last issue of the International Tsunami Information Center Newsletter was published (December 1991). We apologize for this lapse and any inconvenience it may have caused. This abbreviated edition of the ITIC Newsletter will be followed by a 1993 year-end publication providing coverage of the Tsunami Symposium (Tsunami '93), ITSU-XIV (Tokyo, JAPAN), news events and upcoming announcements to date.

With this latest issue of the ITIC Newsletter, we are pleased to introduce Dennis Sigrist as the Acting Director of ITIC. Mr. Sigrist, formerly assigned at the United States National Weather Service Headquarters, has been detailed to the ITIC until such time a permanent Director is in place.

Another new face at ITIC is Mrs. Susannah Eilenberg. Mrs. Eilenberg, ITIC's Secretary and Administrative Assistant, joined ITIC in January 1992. She has handled many of the office's day-to-day administrative activities during the last year. Please be sure to stop by ITIC during your next trip to Honolulu and meet the new office staff.

Visitors to ITIC in 1992 and 1993

Visitors to ITIC and PTWC in January 1992 included Major General John Bowzing and his lovely wife Lona, (from United Kingdom) and Mr. David Doyle of Honolulu. Major General Bowzing is the retired Chief of Royal Engineers of the United Kingdom. Mr. Doyle is a well-known writer. The visitors were given a tour of the facilities at PTWC and a briefing by Dr. William J. Mass of PTWC.

Mr. Joseph Chung, Chief Technical Advisor, UNDRO/SPPO visited ITIC, on Tuesday, March 31, 1992, to discuss cyclone warning awareness in the South Pacific and to review ways in which NOAA may be of assistance to UNDRO/SPPO.

Dennis Sigrist, ITIC's Acting Director, had the pleasure of meeting with Mr. William Sites in May 1993, representing National Weather Service Headquarters in Silver Spring, Maryland. Mr. Sites visited the ITIC facility as well as the Pacific Tsunami Warning Center, water level and seismic field sites on Oahu and discussed tsunami research issues with representatives at the University of Hawaii.

Ms. Joanne Burke with the Office of United States Foreign Disaster Assistance - United States Agency for International Development met with Dennis Sigrist, William Sites and Mark Koehn while on business in the Washington, D.C. area. Ms. Burke, the Regional Disaster Field Advisor assigned to Suva, Fiji, briefed the meeting on her responsibilities that cover a large geographical area in the South Pacific. The discussion included a review of the historical tsunami record for the area as well as progress being made regarding disaster planning and public education.

Dr. Viacheslav K. Gusiakov, Computer Center - Novosibirsk, Russia, visited ITIC on June 29, 1993. He had the opportunity to meet with Mr. Richard Hagemeyer, ITSU Chairman, and Dr. Eddie Bernard, NOAA/PMEL, to discuss tsunami related business.

IOC/ITSU

ITSU-XIV

The Fourteenth Session of the International Co-ordination Group for the Tsunami Warning System in the Pacific (ITSU-XIV) will take place, at the invitation of the Government of Japan, at the Japan Meteorological Agency (JMA) Tokyo, Japan, 30 August - 3 September 1993. IOC Circular Letter No. 1371, dated 10 March 1993, was sent to all National ITSU Contacts inviting their participation at ITSU-XIV, requesting submission of National Reports as well as other proposals for future projects in the areas of tsunami warning.

Further dispatches of ITSU-XIV documents are planned for this summer. Mr. Masaro Saiki, Senior Assistant for International Affairs (JMA), is the local organizer for the meeting.

Nicaragua Joins ICG/ITSU

IOC is pleased to announce that Nicaragua has been kindly accepted as the Twenty-Sixth Member of the ICG/ITSU. This request was enthusiastically endorsed by the Chairman of the ICG/ITSU, Mr. Richard Hagemeyer. Recent correspondence between the IOC Secretariat, Dr. Gunnar Kullenberg, and Mr. Pablo Vijil Ycaza, Minister of Construction and Transport, Managua, officially announced Nicaragua's Membership in the Tsunami Warning System in the Pacific. Mr. Claudio Gutierrez Huete, General Director of the Nicaraguan Institute of Territorial Studies (INETER) has been nominated to serve as the ICG/ITSU National Contact for Nicaragua.

European Tsunami Working Group Holds Meeting

The European Geophysical Society's (EGS) Tsunami Working Group held a business meeting following the EGS Tsunami Symposium in Edinburgh on April 8, 1992. Professor Stefano Tinti (Italy) presided.

Among other business items, the Group was read the resolution of the XIII Session of The International Coordination Group for the Tsunami Warning System in the Pacific (ICG/ITSU) held in Ensenda, Mexico, (10-13 September 1991) pertaining to future mutual cooperation on tsunami preparedness, and the letter of the Chairman of ICG/ITSU, Mr. Richard Hagemeyer to the Group pertaining to the same issue. Participants discussed the issue and the need for closer affiliation and its cooperation with ICG/ITSU, particularly in the areas of tsunami preparedness, education, and research.

In addition, to this, the Group discussed the need for its existence as an independent working group within

the framework of EGS, rather than as a subgroup under the present Natural Hazards Committee. Participants felt strongly that it is important for the Group to continue as a separate entity with EGS as its goals were better defined and more unique than those of other hazard groups. Finally, a decision was reached to publish the abstracts from the EGS Tsunami Symposium as a special issue of the Journal of Tsunami Hazards of the Tsunami Society.

Tsunami Warnings for Pyongyang and Beijing

During the Twelfth Session of the International Coordinating Group for the Tsunami Warning System in the Pacific (ICG/ITSU), considerable concern was expressed about communications with the Hydrometeorological Service (HS), Pyongyang, Democratic People's Republic of Korea and the National Marine Environmental Forecast Centre (NMEFC), Beijing.

These two agencies reported that they were not receiving either the test communications sent each month by the Pacific Tsunami Warning Center (PTWC) in Honolulu or the actual tsunami watch and warning messages sent by the PTWC. Mr. Richard H. Hagemeyer was charged with the responsibility of correcting the matter.

As a result of his efforts, the following were determined:

Both the communications test and warning messages are transmitted on the WMO GTS using the header, WEPA40 CCCC. ("CCCC" being the ICAO four-letter ID for the transmitting office, respectively. Routing from the PTWC is via the U.S. National Weather Service Telecommunications Gateway (NWSTG) to Tokyo with relay to Beijing (and others)).

It has been determined that the JMA Tokyo does make the relays to the Regional Telecommunications Hub (RTH) at Beijing, but provision for onward relays to the HS, Pyongyang and to the NMEFC, Beijing has not been established, nor for confirmation of receipt messages back to PTWC, Honolulu.

Mr. Wu Xianwei, Director of Weather Forecasting and Warning, State Meteorological Administration (SMA), People's Republic of China, has advised that the computer system could be programmed to relay the WEPA40 PHNL messages to the two agencies on the basis of bilateral agreement were WMC Washington to inform RTH Beijing on this matter formally.

Along with this, arrangements will be made for routing acknowledgement messages via the GTS to PTWC, as for other recipients and for the transmission of tsunami warnings.

National and Area Reports

Sea Level Monitoring Network for Central America

Oceanographer, Alejandro B.

Gutierrez, Coordinator of the Tidal State Program ("SERMAR") of the National Institute of Meteorology in Costa Rica, has informed ITIC of efforts being made to improve the Sea Level Monitoring Network in the Caribbean and on the Pacific side of Central America. This is an area where tsunami generation is possible and the development of a sea level monitoring network would benefit the Tsunami Warning System.

Dr. Gutierrez has been in contact with Dr. George Maul (NOAA/Miami) and other people in the Caribbean regarding the establishment of a sea level network for the region. Furthermore, contacts have been made with other Central American institutions responsible for sea level recording stations.

As a result of these efforts, a tide gauge is being established at Puerto Quetzal (Guatemala). Eventually, it is hoped that other countries such as El Salvador and Nicaragua will establish water level monitoring stations.

Presently, Dr. Gutierrez and two colleagues have submitted a proposal to the National Council of Research of Costa Rica related to measurements of sea level changes and geodetic control in the Peninsula of Guanacaste, a Costa Rican region associated with a fault thought to be the possible source of a major seismic event in the near future.

Such an earthquake could generate a local tsunami which could be damaging at Samara Beach, and elsewhere.

New Director for Chilean Hydrographic and Oceanographic Service

At the beginning of 1992 Captain Don Carlos BIDART Jimenez assumed responsibility as Director of the Hydrographic and Oceanographic Service of the Chilean Navy, in Valparaiso.

He is succeeding Captain Fernando Le Dantec Gallardo who assumed another command.

UNDRO/Disaster Library Kits

A joint project of the UNDRO Library and the South Pacific

Programme Office (SPPO) in Suva, Fiji is the development of Disaster Library Kits. The "Kit" is a collection of bibliographic information on publications pertaining to disasters prevalent in the South Pacific region: i.e., cyclones, floods, tsunamis, volcanic eruptions, earthquakes, droughts and landslides.

The "Kit" is intended to be a useful tool for all established and future disaster centers, by serving as core material for the creation of small libraries in the various countries in the South Pacific region.

For US$35 one can receive a complete "Kit" dealing with general disaster and environmental management. The information provides title, author, publisher, table of contents and number of pages publications: ten on general disaster management and 90 publications selected in accordance to each country's specific disaster proneness, i.e., 20 on floods, 20 on

earthquakes, 20 on landslides and 20 on volcanic eruptions, five on drought, and five on tsunami for Papua, New Guinea.

Included in each "Kit" will be the cover and contents pages, as well as the name and address of the publisher of each document. Such a resume will enable the disaster centres to choose at a glance the relevant publications they wish to purchase. The cost of all the publications contained in the "Kit" will be approximately US$3,000.

The role of such disaster libraries is, principally, to provide the disaster centres with adequate documentation for their own needs, and secondly, to enable easy and rapid information and communication between the centres. This should assist them both in their self-development, and in the creation of their training programmes, without relying too much on foreign expertise. Consequently, the same reference material, in accordance to each country's specific needs due to their disaster proneness; will be included in each "Kit."

Other Reports

Tsunami Bulletin Board (1992 Nicaragua Event)

As part of the Tsunami Community's effort to foster the exchange and dissemination of information and related news on recent tsunami events, the Pacific Marine Environmental Laboratory (PMEL), Seattle, Washington, USA, has established an interactive computer-based bulletin board. Available using INTERNET, the Tsu-Nica bulletin board provides a forum for discussions and ideas about this devastating tsunami while encouraging and facilitating the sharing of data. The present Tsu-Nica user list, growing in numbers daily, includes participants from many countries. If you have access to INTERNET and are interested in participating please contact either Laura McCarty or Dr. Frank Gonzales at PMEL. Laura McCarty can be reached at:

INTERNET	- lmccarty@noaapmel.gov
FAX	- (206) 526-6815
Phone	- (206) 526-6763
Mail	- NOAA/PMEL, 7600 Sand Point Way, N.E., Seattle, WA 98115 (USA)

Complete user instructions are available on-line. Tsu-Nica represents the first time PMEL has connected their bulletin board capability to INTERNET. There may be a few start-up problems initially. As the INTERNET user community grows and connectivity improves, ITIC will be assessing opportunities to develop similar capabilities that will complement the PMEL effort. Your comments are encouraged.

XVII General Assembly European Geophysical Society - United Kingdom (U.K.)

The XVII General Assembly of the European Geophysical Society held its

meeting at the University of Edinburgh, in Edinburgh, United Kingdom, from 6-10 April 1992. The meeting was sponsored by the International Association for the Physical Sciences of the Oceans (IAPSO), the Copernicus Society, the British Geological Society, the University of Edinburgh, the British Hydrological Society and many more professional societies and governmental groups. The five day Assembly included a symposium on the Theoretical and Observational Aspects of Tsunamis (see related article).

European Geophysical Society Tsunami Symposium - Edinburgh, Scotland, U.K, April 8, 1992

A Tsunami Symposium on the Theoretical and Observational Aspects of Tsunamis was held on April 8, 1992, during the XVII General Assembly of the European Geophysical Society at the University of Edinburgh, in Edinburgh, Scotland, U.K. Professors D.E. Smith and Alastair G. Dawson convened the Symposium.

A field excursion was conducted on April 7, 1992 to the eastern coastline of Scotland near Edinburgh where field evidence was observed of a large historical tsunami which struck Scotland approximately 7,000 years ago as a result of one of the world's largest submarine landslides (the second Storegga slide) in the Norwegian Sea west of Norway.

In addition to these events, the Tsunami Working Group of the European Geophysical Society held a business meeting. The following is a list of papers and posters presented at the Tsunami Symposium:

European Geophysical Society, Edinburgh, Scotland-April 8th Theoretical and Observational Aspects of Tsunamis Conveners were L. Mendes Victor and A.G. Dawson

S. Nakamura - Transoceanic Tsunamis Observed in 1985

M. A. Zhdanov - On The Theory of Tsunamis Generated by a Source in the Earth's Crust

S. Soloviev - Mediterranean Tsunamis and Ocean Bottom Seismograph Data

G. Pararas-Carayannis - An Overview of Tsunami Research

S. Tinti - Volcanic Tsunamis in The Tyrrhenian Sea, Italy

A. C. Yaiciner, A. Akyaril, D. Oner - A Discussion on The Wave Data Containing Weak Tsunami in The Sea of Marmara

G. A. Papadopolos, L. Polymenakos, M. Tsimplis, G. Vlachakis - An Exceptional Sea-Wave Observed in The Aegean: A Geological or Meteorological Event

Announcements

V. D. Djumagallev, Ye A. Kulikov, S. L. Soloviev - Registration of Small Tsunami on February 16th, 1991, at Shikotan Island and Response of Malckuril'skaya Bay

R. F. Henry and T. S. Murty - Model Studies of The Effects of The Storegga Slide Tsunami

D. Long - A Review of Sediment Instability On The Continental Slope of NW Europe

J. L. Svendsen - Tsunami Deposits in Lake Basins on The Western Coast of Norway

A. G. Dawson, B. Atwater and S. Shi - Tsunami Sediment Deposition: Examples From Seattle (1100 BP) and Arica, Chile (1868 AD)

C. Andrade - Tsunami Generated Forms in The Algarve Barrier Islands, Southern Portugal

J. Szulc - Recognition and Interpretation of Palaeoseismic Activity and Tsunami-Generated Sedimentary Structures: An example from the Muscheikalk Carbonates (Middle Triassic), Central Europe

F. Imamura (Tohoku) - Numerical Simulation for Current and Sedimentation Due to Tsunami

M. A. Baptista, P. Miranda, L. Mendes Victor - Maximum Entropy Analysis of Tsunami Data from 28th February 1969 (Portugal Earthquakes) (Poster)

I. D. L. Foster - Possible Tsunami Deposition in The Scilly Isles, SW England Associated With Lisbon Earthquake of 1755 AD

S. Shi - Physical Characteristics of Tsunami Sediments

C. Andrade - Tsunami Generated Forms in The Algarve Barrier Islands, Southern Portugal

J. Z. R. Simoea - Assessing the Tsunami Risk Using Instrumental and Historical Records

Of Interest

On a historical note of interest, Jim Lander, associated with World Data Center-A, has found a reference to the high water level that occurred in December 1866 in the Strait of Juan de Fuca and northern Puget Sound (British Columbia and Washington State).

The Daily British Columnist and Victorian Chronicle, Vol. 17, No. 10, page 3, column 2, reported, "The tide yesterday was higher than it had ever been known to rise by the inhabitants: They (pilots) say there were 20 feet six inches and upward on the bar, and part of the Indian Rancheria in the vicinity of Bolton's shipyard was inundated. It remained high all day, indicating the prevalence of heavy southerly gales outside the strait."

Thus, the high water was apparently

due to an extreme storm event in the North Pacific. Such historical high water events can be confused with high water from tsunamis. Our thanks to Jim Lander for his efforts in locating this information.

Announcements

International Tsunami Symposium, Tsunami '93 IUGG/ IOC International Tsunami Symposium

The International Tsunami Symposium, Tsunami '93, of the Tsunami Commission of the International Union of Geodesy and Geophysics (IUGG) in conjunction with the IOC, International Coordination Group for the Tsunami Warning System in the Pacific, will be held in Wakayama, Japan. Scientists, engineers and specialists who have an interest in tsunami research and mitigation are invited to participate.

The Symposium is being organized by the Organizing Committee of the Japan Society of Civil Engineers, and will be held at the Wakayama Tokyu Inn in Wakayama City, Japan. Social and recreation programs as well as a post symposium technical tour are planned. The biannual meeting of the Tsunami Society is being organized to coincide with this symposium (see related article).

The principal aim of the symposium is to bring together an international forum of scientists, engineers and specialists working in tsunami research and mitigation, to exchange current information on technical advances and to discuss progress in the science. About 70 papers will be presented in a technical session. The Wednesday, August 25, afternoon session will complement the workshop with papers on operational tsunami warning systems, plans for improvement and related topics. Papers will be published in a volume of proceedings, which will be distributed to each full registrant upon arrival at the symposium.

Selected papers will be published as a special issue of Advances in Natural and Technological Hazards Research, Kluwer Academic Publishers.

Tsunami Society; Meeting Announcement & Call for Nominations

There will be a meeting of the Tsunami Society at the Tsunami Symposium, TSUNAMI '93, in Wakayama, Japan (August 1993). This will be a short meeting to discuss business of the Society.

Nominations are requested at this time for an election of society officers. Members wishing to serve as officers may submit their own names, or members may submit the names of other members who have an interest. The positions to be filled include President, Vice President, Secretary, and Treasurer. Present officers are:

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President - Dr. Fred Camfield
Vice President - Prof. Stefano Tinti
Secretary - Dr. George Pararas-Carayannis
Treasurer - Dr. Augustine Furumoto

It is desirable that the person serving as President be able to attend tsunami related sessions or symposia sponsored by the IUGG Tsunami Commission, European Geophysical Society, or other organizations. No support is available from the Tsunami Society for officer travel or other expenses.

Nominations for officers should be submitted to:

Dr. Fred E. Camfield
President, Tsunami Society
700 Longview Street
Vicksburg, Mississippi 39180 USA

The Fifth International Conference on Natural and Man-Made Hazards

Hazards-93 will take place on 29 Aug - 3 September, 1993 in Qingdao, China. Theme of the Conference is Disaster Mitigation: Scientific and Socio-Economic Aspects.

It is organized by the International Society for the Prevention and Mitigation of Natural Hazards (NHS), the IAPSO Commission on Natural Marine Hazards, the Chinese Academy of Sciences, and the Institute of Oceanology, Academia Sinica.

This international symposium is the fifth in the continuing interdisciplinary series begun in 1982, with the first being held in Honolulu, Hawaii. The objectives of this series of symposia on natural and man-made hazards are to promote the advancement of hazard sciences, to perceive and explore those aspects that may be similar among some of the various hazards, to review the newest developments in a few selected fields, and also to outline new directions for future research.

All those interested in natural and man-made hazards and their mitigation will not only find much value in the formal sessions, but will also have a unique opportunity to confer personally with eminent researches and policy makers in this important field. Please note that Hazards-93 will be held in the week following the IUGG Tsunami Commission Symposium (Tsunami '93). For further information, please contact:

Dr. T. S. Murty, Chairman, Scientific Committee
Institute of Ocean Sciences
P.O. Box 6000, Sydney B.C. V8L 4B2, CANADA

International Symposium on Urban Disaster Reduction

Tianjin Municipal People's Government, in cooperation with the State Seismological Bureau of China and China Disaster Prevention Association, will hold the International Symposium on Urban Disaster Reduction from May 22-25, 1994 in Tianjin, China.

The Symposium aims at providing government officials, experts, and scholars from various countries an

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opportunity to exchange the research results and successful experience in urban disaster reduction.

Through the exchange, we can better understand the present situations of urban disasters, their characteristics and the measures in urban disaster prevention so as to reduce all kinds of disasters threatening the human beings to the minimum degree.

Sponsor
Tianjin Municipal People's Government, P.R. China
State Seismological Bureau of China
China Disaster Prevention Association

Chairman
Professor Lu Huansheng, Vice Mayor of Tianjin Municipality, Hydraulician

Just Published

Science of Tsunami Hazards

The Science of Tsunami Hazards, the International Journal of the Tsunami Society, has just published and is now mailing Volume 11, Number 1 to their membership. Articles of interest include:

Transoceanic Tsunamis Observed in 1985, S. Nakamura

Expectation of Destructive Far-field Tsunamis from the Aleutian-Alaska Subduction Arc, A.S. Furumoto

On Some Exceptional Seismic(?) Sea Waves in the Greek-Archipelago, G. A. Papadopoulos

Tsunami Sedimentation Sequences in the Scilly Islands, South-West England, I. D. L. Foster, A. G. Dawson, S. Dawson, J. A. Lees, L. Mansfield

Analysis of Ocean Level Oscillations in Malokuril'Skaya Bay Caused By Tsunami of 16 February 1991, V. A. Djumagaliec, E. A. Kulikov, S. L. Soloviev

Tsunami Catalog, Mexico

Catálogo de Tsunamis (Maremotos) en la Costa Occidental de México (Catalog of Tsunamis on the Western Coast of Mexico) by A. J. Sanchez and S. F. Ferreras has been published in both Spanish and English by the World Data Center-A for Solid Earth Geophysics.

This catalog by Sanchez and Ferreras for the active zone of Mexico is an important improvement to earlier catalogs. The publication is available from:

National Geophysical Data Center
NOAA, E/GC1
325 Broadway
Boulder, Colorado 80303-3328, USA

Priced at US$10 (including shipping and handling); please refer to publication #SE-50 when ordering.

Pacific Tsunami Warning Center (PTWC)

TSUNAMI WARNING!

The International Coordination Group for the Tsunami Warning System in the Pacific (ITSU) at its Thirteenth Session in Ensenada, Mexico, encouraged the preparation of a book designed to inform young persons about tsunamis and the dangers which they present and what should be done to save lives and property. This booklet, TSUNAMI WARNING!, is the result of that encouragement. Dr. George Pararas-Carayannis, Ms. Patricia Wilson, and Mr. Richard Sillcox are the authors. Graphic design and color illustrations are by Mr. Joe Hunt. The preparation and printing of the book were supported by a very generous grant from the Intergovernmental Oceanographic Commission. ITIC has a limited number of the booklets available for distribution.

PTWC Report

As noted in the December 1991 Newsletter, Mr. Michael Blackford was appointed the new Director of PTWC in August 1991.

A number of other personnel transitions have occurred since that time. Bob Uchida, Senior Electronics Technician and primary field technician responsible for PTWC's satellite telemetered water level measurement system, was transferred and replaced by Richard Nygard. Rich has quickly learned the technical aspects of the system and has made a number of trips to field sites. Also in 1991, Ms. Jill Wessel came to PTWC from the University of Hawaii as a member of the geophysical staff. Dr. Laura Kong joined PTWC as Chief Seismologist in early 1992.

Dr. Kong was previously at the University of Tokyo Earthquake Research Institute. With the retirements of Nona Mazey and Frank Takenouchi in 1992, Marilyn Ramos and Steve Wallace joined the PTWC staff. Marilyn is responsible for office administrative functions while Steve is involved with the center's electronics both locally and in remote field locations.

INTERNET

As previously reported, the INTERNET communications network has been tapped for use by the tsunami community to share information on the disastrous Nicaraguan tsunami of 1992.

PTWC routinely uses INTERNET with its far reaching connectivity to communicate with users around the world. INTERNET provides a rapid, cost-effective method for exchanging and disseminating seismic and tsunami warning information.

The communications system, which utilizes machine-independent Transmission Control Protocol/Internet Protocol (TCP/IP) to enable remote computer logins, file transfer, and electronic mail, has gained acceptance for its robust and versatile capabilities for connecting computers over wide-area worldwide networks.

For example, automatically-estimated USGS/NEIC earthquake hypo-

centers and Harvard University Centroid Moment Tensor solutions are sent automatically to PTWC, and phase and location information are also exchanged among the IRIS DMC, NEIC, and PTWC through Internet electronic mail.

In addition, PTWC uses Internet's *telnet* feature to remotely log into the NEIC real-time computer and into the Australian Seismological Centre to retrieve arrival time data for its tsunami operations, and will use *ftp* (file transfer protocol) to remotely copy seismic network; i.e., GSN, USNSN, and USRSN, waveform data to PTWC computers for use in real-time waveform inversion for earthquake moment, mechanism, and source-time duration.

Pacific Tsunami Warning Center (PTWC)

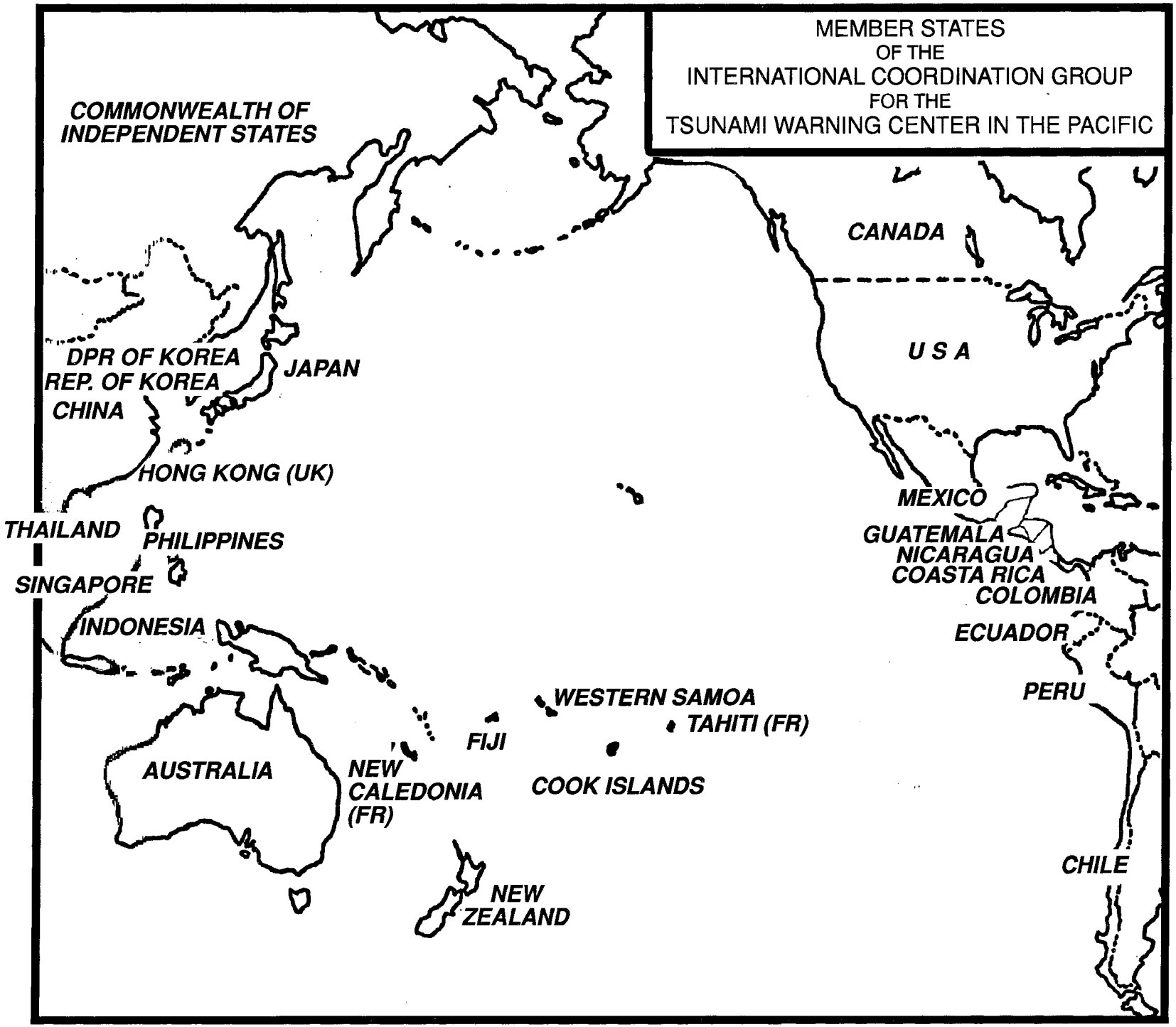
Summary of Pacific Basin Earthquakes
With Surface Wave Magnitudes Equal to or Greater Than 6.5
(December 1991 Through December 1992)

Event No.	Event	Location	Action Taken
1991-20	Dec 13 0234Z 6.5	Kurile Islands 45.2N 151.8E	No TIB[1] issued
1991-21	Dec 22 0843 7.5Z	Kurile Islands 44.9N 151.6E	TIB issued
1992-01	May 15 0705Z 7.2	E. Coast of New Guinea 6.1S 147.6E	TIB issued
1992-02	May 17 0949Z 6.7	E. Coast of Mindanao 8.0N 126.9E	TIB issued
1992-03	May 17 1015Z 7.1	E. Coast of Mindanao 8.5N 125.6E	TIB issued
1992-04	May 27 0513Z 6.8	Santa Cruz Islands 10.3S 165.3E	TIB issued
1992-05	Jul 10 0931Z 6.5	Southern Kurile Islands 44.3N 149.8E	No TIB issued
1992-06	Sep 02 0016Z 6.8	Off Nicaragua Coast 13.8N 87.5W	No TIB issued
1992-07	Sep 30 0538Z 6.7	Adak Island 51.3N 178.1W	No TIB issued

Pacific Tsunami Warning Center (PTWC)

Event No.	Event	Location	Action Taken
1992-08	Oct 11 1924Z 7.4	Vanuatu 18.9S 169.2E	TIB issued
1992-09	Oct 15 2237Z 6.6	Solomons/Vanuatu Area 12.2S 167.3E	TIB issued
1992-10	Oct 17 0833Z 6.7	Panama/Colombia Border 7.9N 77.2W	No TIB issued
1992-11	Oct 18 1512Z 7.3	Northern Colombia 7.3N 76.4W	TIB issued
1992-12	Oct 23 1304Z 6.5	New Britain 4.1S 153.2E	No TIB issued
1992-13	Nov 8 0343Z 6.6	N. Fiji Basin 15.0S 179.7W	TIB issued
1992-14	Dec 12 0530Z 7.2	Flores Sea 7.4S 123.6E	No TIB issued

[1] Tsunami Information Bulletin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